DOCUMENT RESUME

ED 278 556 SE 047 720

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TITLE The Effects of Using Algebra Notecards on Algebra Achievement of College Students.
PUB DATE 16 May 86
NOTE 22p.; Paper presented at the Annual Education Colloquium (11th, Pittsburgh, PA, May 16, 1986).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Algebra; Cognitive Style; *College Mathematics; Conference Papers; Higher Education; *Mathematics Instruction; *Problem Solving; *Review (Reexamination); Student Characteristics; Study Skills; *Teaching Methods

ABSTRACT

The effect on algebra achievement of college students of using a specific study method, algebra notecards, was examined. Whether achievement differed for adult learners and traditional college students, and the interaction between the study method and the status of the learner were also investigated. The research was conducted at the University of Pittsburgh with an evening college algebra class. Students were randomly assigned to seven problem-solving sessions, with four groups using notecards and three groups not using notecards. Notecards were distributed eight times, after material had been explained in lectures. During free moments, students were to randomly deal a card and analyze or solve the problems on it. Based on the criterion of reported use of the notecards two or more times, the number in the experimental group was cut from 71 members to 47: 35 traditional students and 12 adult learners. The control group consisted of 50 members: 38 traditional students and 12 adult learners. No significant differences were found between the algebra achievement of those using or not using notecards, between adult and traditional students, or between study method and learner status. Attendance apathy was discussed. (MNS)

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# THE EFFECTS OF USING ALGEBRA NOTECARDS ON ALGEBRA ACHIEVEMENT OF COLLEGE STUDENTS

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by

Ann Massey

Paper Presented at
The Eleventh Annual Education Colloquium
University of Pittsburgh
May 16, 1986

SE 047 720

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The purpose of this study was (1) to examine the effects of using a particular study method, that is the use of algebra notecards, on the algebra achievement of college students, (2) to investigate whether there was a difference in algebra achievement between adult learners and traditional college students, and (3) to see if there was an interaction between the study method and the status of the learner. The status of the learner was determined by the number of years that had elapsed since the student's high school graduation. Students were classified as traditional college students if they were enrolled in the class within five years of high school graduation and as adult learners if it had been more than five years since their high school graduation. Algebra achievement was measured by a departmental final examination.

Reasons for success or failure in college algebra courses may be attributed not only to mathematical backgrounds, but to cognitive styles and to methods of studying mathematics. This research was an effort to help field-dependent students learn mathematics by using a structured method based on information processing theory and a continuous review approach.

Avoidance of mathematics has been a limiting factor in learning pursuits. Sells (1978) reported that avoiding mathematics was a crucial issue in the choice of a college major and hence of a career. As more occupations have incorporated technology, especially computer technology, the need for mathematical knowledge has become essential. Career goals demand and academic programs require mathematical skills and concepts.

Colleges, recognizing the needs of students for quantitative reasoning skills, are requiring that students either place out of or take a college algebra course. Consequently, traditional college students and adult learners are finding themselves enrolled in basic mathematics courses such as college algebra.

College students enter algebra classrooms with diverse mathematical backgrounds accentuated by differences in ages. Some students, especially adult students, have never studied algebra. Some have studied it and failed. Others have studied algebra and achieved levels ranging from minimum competency to superior understanding. Likewise, once students are in the college classroom, they differ in their achievements in algebra. Some students excel; others learn algebra

satisfactorily; still others fail in their attempts to pass the algebra courses. Reasons for success or failure may be attributed not only to mathematical backgrounds, but to cognitive styles and to methods of studying mathematics.

The cognitive style of the student may be a contributing factor in whether the student succeeds in algebra. A cognitive style is a way of processing information. Cognitive styles incorporate how a person perceives, remembers, thinks, and solves problems. Although there are many different dimensions of cognitive styles, a dimension that has been widely studied is that of field-dependence-independence.

Field-dependence versus field-independence refers to a consistent mode of approaching the environment in global versus analytical terms. "It denotes a tendency to experience events globally in an undifferentiated fashion as opposed to articulating figures as discrete from their backgrounds. The field-independent pole includes competence in analytical functioning while the field-dependent pole reflects less competence in analytical functioning" (Messick, 1976, p. 14). Thus, field-independent persons tend to be analytical and logical whereas field-dependent persons tend to be global

and unstructured in their approach to learning tasks.

Roberge and Flexer (1983) and Mrosla (1983) found that field-independent students outperform field-dependent students in mathematics. Students in college algebra classes who are field-dependent may need more structured study methods to achieve well in algebra. Study methods, which help students process information, include textbook reading, lecture notetaking, memory development, studying, test-preparation and test-taking strategies. These methods not only add structure but they help students become more efficient and effective learners.

Various programs have been offered by the University of Pittsburgh's Learning Skills Center to help students learn mathematics. These programs have included individual counseling, how-to-study-mathematics workshops and study-skills workshops. While working with college students at the Center, this researcher has made several observations.

Many students remark that they can do the homework problems correctly but that they "go blank" on tests. Often these students can solve specific mathematics problems when they try them immediately after the lecture. They are even able to pass quizzes on a limited

amount of material. However, when confronted with examinations on several chapters of material, they are not able to cope. These students often seek help for test anxiety when the problem actually lies in poor storage of material in long-term memory.

The Information Processing Study System developed by Materniak (1982) suggests efficient and effective methods of taking in, manipulating, storing, and retrieving information. Materniak believes that active processing by maintenance and elaborative rehearsal is the key to retention of information. Maintenance rehearsal or repetition burns into and recycles the information into the long-term memory. Elaborative rehearsal is clustering, organizing, or relating individual pieces of information to units of information. Once in the long-term memory, information can be recalled to the short-term memory, which is then referred to as the working or conscious memory.

John Saxon (1982, March) states that algebra is not difficult, but it is different. He believes that students of average ability can master algebra if topics are presented in increments and if sufficient time for understanding is provided. He also believes that students learn the abstractions of algebra by repetition.

Consequently, Saxon's method involves introducing topics in increments and continuously reviewing previous topics.

It seems that a study method that would add structure to learning, that would help students make connections between topics, and that would simulate incremental, continuous review would help field-dependent students learn algebra. The study method that was tried was that of the use of algebra notecards.

The algebra notecards used in this study were 3x5 inch exercise cards developed by the researcher. They were designed for practice and review and to help students reflect on similarities and differences between problems. Each notecard contained one to five problems dealing with a particular topic. It was hoped that through the use of the notecards, the "burning in" process of maintenance rehearsal or repetition would be supplemented and the process of elaborative rehearsal involving organization and relations would be strengthened.

## Statement of the Problem

The purpose of this study was (1) to examine the effect of using a specific study method, that is the use of algebra notecards, on algebra achievement of college students, (2) to investigate whether there was a

difference in algebra achievement between adult learners and traditional college students, and (3) to see if there was an interaction between the study method and the status of the learner. The null hypotheses tested were:

1. There is no significant difference in algebra achievement between college students who use algebra notecards and college students who do not use algebra notecards.
2. There is no significant difference in algebra achievement between adult learners and traditional college students.
3. There is no significant interaction between the the study method and the status of the learner.

## The Study

The research was conducted at the University of Pittsburgh in the fall of 1985. The course in which the study was conducted was a large (121 students) evening college algebra class. The students in the class were classified as traditional college students or as adult learners according to the number of years that had elapsed since the student's high school graduation. A traditional college student was defined as a student who was enrolled in the college course within five years after high school graduation. An adult learner was

defined as a student who was enrolled in the college course five or more years after high school graduation. Ninety-five students in the course were traditional college students and twenty-six were adult learners.

The fifteen-week course consisted of two one-hour large-group lectures and two one-hour small-group problem-solving sessions each week. The lectures were given by the researcher. The seven problem-solving sessions were conducted by six mathematics undergraduate teaching assistants (UTAs) previously trained by the researcher. (One UTA conducted two problem-solving sessions.)

On the first day of class, students were randomly assigned to problem-solving sessions. Each problem-solving session had an enrollment of approximately 25 students. The students in four of the problem-solving sessions served as the experimental group which used algebra notecards while the students in three of the problem-solving sessions served as the control group which did not use algebra notecards. A larger number of students were assigned to the experimental group because it was anticipated that not all of the students in the experimental group would use the algebra notecards.

During the last twenty minutes of the second

lecture, the Group Embedded Figures Test (GEFT) was administered. The test was given to establish whether the class was field-dependent or field-independent or neither.

Algebra notecards were distributed in the experimental problem-solving sessions eight times during the term. The notecards were given out after the material they covered had been explained in lecture. The procedures for using the algebra notecards were explained by the UTAs when they first handed out the cards. Students were to asked to aim at understanding the concepts, principles, and formulas used on each card. The UTAs suggested that the algebra notecards be carried by the student, and during free moments, the student randomly deal himself a card and analyze or solve the problems on that card.

Students were encouraged by the UTAs to ask themselves questions when working with the cards. Some of the questions suggested were as follows. How are the problems on this card similar? How are they different? What are the directions? Can I reword the directions? What different techniques can I use to solve this problem? How do I know when to use different techniques? How does the material on this card relate to material on

another card? Do I make any mistakes when solving problems of this type? What specific mistakes do I make? Does my answer make sense?

To determine to what extent the cards were being used, questionnaires concerning the frequency of use were attached to six quizzes and four exams of the experimental group. A frequency-of-notecard-use chart was kept by the instructor.

A departmental final examination was used to measure the algebra achievement of the students. The multiple-choice examinations were hand scored by the researcher and three graduate teaching assistants. Each of the 40 problems was worth 3 points. One point was given for correctly attempting the problem; one point for correct computations; and one point for choosing the correct multiple-choice answer. The scores were converted to percentages. A two-way analysis of variance (ANOVA) was used to analyze the results.

## Results

### Cognitive Style

The Group Embedded Figures Test (GEFT) was given to determine the cognitive style of the class. Scores for the GEFT range from 0 to 18; a score of zero represents total field-dependence while a score of 18 represents

total field-independence. Norms for the GEFT give the mean score as 11. (Witkin et al, 1971). The mean score for the GEFT administered in the algebra class was 7 which showed that the class was strongly field-dependent. In fact, there were so few field-independent students (only four students scored 15 or more points) that it was not possible, because of the small sample, to compare the algebra achievement of the field-dependent students with the algebra achievement of the field-independent students.

Frequency-of-Notecard-Use

Since the use of notecards was voluntary, no student in the experimental group was required to use the notecards. Since the testimony of use of the cards was self-reported, the validity of the reports depended on cooperation and honesty of the students. One-half of the students in the experimental group reported that they had used the notecards to study for the first examination. However, reported use of the notecards fell throughout the term. In fact, several times almost half of the students neglected to even respond to the frequency-of-use-questionnaire.

A decision had to be made as to what reported frequency-of-use constituted use of the algebra

notecards. It was decided that a reported use of the notecards two or more times during the term would constitute use of the algebra notecards as a study method. Data on students in the experimental group who reported that they had not used the algebra notecards at least two times was eliminated from the statistical analysis of the final examinations.

One hundred twenty-one college students took the final examination in the algebra class. The experimental group contained 71 members, 56 traditional students and 15 adult learners. Using the criteria of having reported the use of the cards two or more times cut the number in the experimental group to 47, 35 traditional students and 12 adult learners. The control group consisted of 50 students, 38 traditional students and 12 adult learners.

Data Analysis

The means and standard deviations for final examination percentages by group and status are given in Table 1. The means for the control group were higher than for the experimental group; the means for adult learners were higher than for traditional students.

The data from the final examinations were analyzed by using the Biomedical Program BMDP2V Statistical Software. The results of the accompanying two-way

Table 1

MEANS AND STANDARD DEVIATIONS FOR FINAL EXAMINATION PERCENTAGES BY GROUP AND STATUS

| Group | Status of Learner: Traditional | | | Adult | | | Marginal |
|---|---|---|---|---|---|---|---|
| | n | M | SD | n | M | SD | |
| Experimental | 35 | 72.57 | 14.56 | 12 | 77.17 | 15.32 | 74.87 |
| Control | 38 | 73.79 | 9.90 | 12 | 81.92 | 22.38 | 77.85 |
| Marginal | | 73.18 | | | 79.54 | | |

Table 2

ANOVA SUMMARY TABLE FOR FINAL EXAMINATION PERCENTAGES

| Source | df | MS | F |
|---|---|---|---|
| Status | 1 | 730.57 | 3.59 |
| Group | 1 | 160.76 | 0.79 |
| Status x Group | 1 | 56.31 | 0.28 |
| Error | 117 | 203.59 | |

None of the F ratios are significant at the .05 level.

analysis of variance (ANOVA) are given in Table 2.

The first null hypothesis stated that there is no significant difference in algebra achievement between college students who use algebra notecards and college students who do not use algebra notecards. The statistical study for this hypothesis produced an F ratio of 0.79 with p=.3765. Therefore, the first null hypothesis was not rejected.

The second null hypothesis stated that there is no significant difference in algebra achievement between adult learners and traditional college students. The F ratio produced for this hypothesis was 3.59 with p=.0613. The second null hypothesis was not rejected.

The third null hypothesis stated that there is no significant interaction between the study method and the status of the learner. The statistical analysis produced an F ratio of 0.28 with p=.6002. Therefore, the third null hypothesis was not rejected.

## Discussion

One of the problems encountered in the study was that the use of the algebra notecards by the majority of the students in the experimental group was not frequent enough to constitute "continuous review." The number of students who did use the notecards frequently composed

too small a sample to be statistically analyzed. Therefore, examining the use of algebra notecards as a method of simulating Saxon's method of incremental, continuous review was not possible.

During the first month of the experiment, the undergraduate teaching assistants (UTAs) reported that students felt using the notecards involved too much work, considering that it was in addition to the homework assigned. This feeling was confirmed by the students' comments on the final questionnaire. One student commented that he did not use the notecards because "the homework was enough. By the time I was done with all of my work, I didn't feel like doing them."

We, who teach large lecture classes in developmental mathematics at the University of Pittsburgh, believe that basic skills are learned by practice and, consequently, we require students to do homework. The departmental syllabus which was used in this course included homework assignments of 40 to 125 problems for each class. Selected problems in these assignments were graded by the UTAs and constituted $4\frac{1}{2}$ percent of the final course grade.

By requiring homework and having UTAs grade that homework, a structured study method for students to use

in building skills had been provided for field-dependent students. When students commented that "I felt homework assignments were enough practice to develop skill" or that "I thought I got enough practice with the problems that were assigned for us in the book," they were, no doubt, correct. The homework method was indeed so structured that it allowed little time to use any other method. Indeed, the required homework took so much time that the time-efficient instrument of algebra notecards was not tried.

The study did not specifically deal with the attitudes of the students. It was not designed to consider the reasons students had for taking the course. I did not consider the students' willingness or unwillingness to work hard to build a skill which, in reality, was worth only 2 college credits. I did not address apathy on the part of many students.

It was this lack of interest that strongly manifested itself in this study. Despite efforts to give students support and to help them achieve in the course, the students, for the most part, did not avail themselves of the opportunities. Although exact numbers are not known, few students came to the office hours of either the UTAs or of the instructor. More disturbing, though,

is the fact that attendance in problem-solving sessions and especially in lecture dropped as the term progressed. One student wrote on the final questionnaire that he "never went to recitation" and consequently never received the notecards. Attendance was not mandatory and few records of attendance were kept. Many students appeared only when attendance was essential; for example, they came to lecture to take examinations.

I can only speculate concerning a reason for attendance apathy. Most traditional college students have taken algebra in high school and are taking the course in college because they have failed to place out of the course. Many of them believe they are in a course they already know and can pass with a minimum amount of studying. Oftentimes they are amazed when they subsequently do poorly or even fail the course.

## Conclusion

Although this particular research produced no significant results, I believe that algebra notecards may be used to help students learn algebraic skills and concepts. Shortening homework assignments and substituting the use of algebra notecards may provide a more efficient and effective study method, especially for field-dependent students in developmental mathematics

courses.

Avoiding mathematics in our technological society limits career choices and learning experiences. Mastering basic mathematical facts, skills, concepts, and principles frees the college student to pursue a greater variety of educational and career opportunities. Using techniques tailored to cognitive styles may help college students succeed in learning mathematics and in turn help them pursue varied occupational and intellectual goals.

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